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The Valuation of Jelutong.

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Introductory.

In a previous number of this Journal, Vol. XV, 1927, No. 3, page 65 an account was given of the preparation and marketing of jelutong. It was pointed out that the standard percentage of moisture for the material was 45 per cent., a premium being paid for any lower moisture content and a corresponding reduction made for an excess of moisture. The accuracy of the moisture content figure is therefore of primary importance in the determination of the value of a consignment.

With such a relatively high percentage variations between the moisture contents of blocks are likely to occur and on account of the increasing importance of jelutong an investigation has been carried out in order to ascertain the extent of these variations in consignments from different sources.

As a result of the publication of the figures it is hoped that action will be taken by those engaged in the industry to amend the basis of valuation for jelutong, since it is not considered satisfactory to allow the law of chance to affect its market value to the extent prevailing under present conditions.

Distribution of Moisture.

When jelutong is refined by boiling with water it becomes highly plastic owing to the partial liquefaction of the resins, and much water is occluded by the material. A large proportion of this water is removed during the moulding of

the product into a roughly shaped block preparatory to pressing. During this stage the jelutong loses much of its plasticity and a tough skin forms on the surface.

There will not be an even distribution of water within the block, since the water will be forced into the spaces between the layers produced as a result of the kneading. The material cannot therefore be described as homogenous.

The presses for making the blocks are also frequently of primitive design, being usually lined with wooden strips in order to prevent adhesion of the material to the iron frame. There is also no means of ascertaining that each block is pressed uniformly.

Pressing consists therefore principally in shaping the block, only a relatively small amount of water being expressed during the process on account of the toughness of the skin and the nature of the material preventing the passage of the water. It is possible, however, that pressing tends to a slightly more uniform distribution of the water within the block.

On storing a block of fresh material with such a high moisture content a comparatively rapid diminution in weight occurs on account of evaporation. In this connection the results of some recent experiments may be of interest. Blocks of jelutong were weighed at Singapore and two days later in Kuala Lumpur, and the average loss during transit was found to be between 1 and 2 per cent., calculated on the weight of the original blocks.

Although the rate of diminution becomes less as the outer layers dry out this does not tend to an even distribution of water throughout the block, and it will be realised therefore that at no stage of its preparation or storage can the moisture in a block of jelutong be regarded as evenly distributed.

Determination of Moisture Content.

The usual method for the determination of the moisture content of a block of jelutong consists in the removal of small portions of material for desiccation. This is not easy owing to the tough and sticky nature of the product, and it is only by means of a sharp knife or axe that a small portion can be removed cleanly.

On account of the relatively high moisture content of the material a small amount of water always exudes when a cut is made, and it is always doubtful whether this water forms part of the portion being removed or belongs to the remainder of the block. Further, some water always remains on the knife or other instrument with which the cut is made.

At least two portions should therefore be removed, one from near a corner, another from near the centre, thus tending to minimise the errors associated with the removal of an individual portion and with the uneven distribution of moisture.

The weighed amounts of moist material are dried to constant weight, usually at 100°C., and the percentage moisture calculated.

When jelutong is being dried three factors affecting difference in weight must be considered, a loss in weight due to desiccation, an additional loss in weight owing to slight decomposition of the material and a gain in weight owing to absorption of oxygen by the heated material. It will be realised that the last two are the important factors when considering the question of drying to constant weight.

As a result of a large number of determinations it has been found that jelutong from certain sources, for example Sarawak, has a tendency to gain in weight when heated to a temperature of 100°C. for a period exceeding six hours.

Although the material darkens considerably on heating and there is a slight odour of decomposition, a gain in weight is frequently recorded on heating for this period. It is difficult to explain the reason for this increase and, until more information is available regarding the composition and stability of the resins present in jelutong, it can only be assumed that two chemical changes, involving absorption of oxygen and decomposition of the material, are taking place simultaneously, the former change at a more rapid rate than the latter.

It is possible that the presence of kerosene in the Sarawak jelutong may affect this material on drying. Kerosene is largely used in Sarawak as a coagulant for the latex, and it

is difficult to remove the last traces of this substance by the ordinary process of refining with boiling water.

When carrying out moisture determinations of jelutong in this laboratory the material is therefore weighed every three hours and, when an increase in weight is recorded, the lowest weight is taken as a basis for the calculation of the moisture content. It is realised that in any case the results can only be regarded as approximate but, since this procedure is always followed, the results are comparable.

About four years ago a large number of determinations by the method described above were made by Mr. V. R. Greenstreet, Assistant Agricultural Chemist, who found considerable variations between the moisture contents of samples cut from similar positions in the same block. Thus, in one case, the figures for the moisture contents of samples taken from the four corners of the same block were found to be 47.8, 48.5, 49.1 and 54.7 per cent. respectively, while two samples taken from the central portions of the same block gave 50.2 and 50.9 per cent. respectively.

For the accurate determination of the moisture content of a block it was evident that little reliance could be placed on this method, unless a large number of samples were removed, and another method was therefore worked out by Mr. Greenstreet in which the whole of the material in the block was used for the determination. This method may therefore be regarded as an absolute method for the determination of the moisture content of a block.

The block is weighed and cut in pieces. The pieces are passed two or three times between crepeing rollers and made into a length of thick crepe. The crepe is dried superficially by shaking off the drops of water and wiping the surface with a cloth. The length of crepe is rolled up and weighed. A fraction of the weight, one-quarter or one-fifth, dependent on the weight of crepe, is taken by cutting a transverse section from the roll, and the process of crepeing, wiping and removing a similar fraction of the weight of the resulting roll repeated. This portion is creped finely, dried in a warm cupboard for 10 hours at a temperature of about 40°C. and weighed on cooling. An aliquot portion of this crepe is taken and dried to constant weight in a steam oven.

The following example of the method of calculation may prove useful:—

	grammes.		Weight of moisture. grammes.
Weight of block ...	3,600		
Weight of block after crepeing	2,835		
Loss of moisture ...	765		765
Weight of one-fifth portion of crepe ...	567		
Weight after crepeing ...	550		
Loss of moisture ...	17		
Loss of moisture for whole block		17 x 5 =	85
Weight of one-fifth portion of crepe ...	110		
Weight after crepeing and drying at 40°C. ...	90		
Loss of moisture ...	20		
Loss of moisture for whole block		20 x 25 =	500
Weight of dish ...	32.375		
Weight of dish + jelutong ...	37.375		
Weight of jelutong ...	5.000		
Weight of dish + jelutong after drying ...	37.175		
Loss of moisture ...	0.200		
Loss of moisture for whole block	= .200 x 25 x 90 / 5	=	90
		Total	1440

Moisture Content = 40.0 per cent.

On account of the tendency for some material to oxidise, especially when creped and heated, a suggestion was made that the result obtained by this method might be low owing to the loss in weight due to partial desiccation at 40°C being affected by an increase in weight due to absorption of oxygen during this period.

Two series of experiments were therefore carried out with both F.M.S. and Sarawak jelutong. In one series the material was sampled after the second crepeing and placed in the steam

oven, while in the other the procedure outlined above was followed.

The experiments with the F.M.S. jelutong showed that the differences between the results obtained by the two methods were negligible, being within the limits of experimental error. Further, it was found that, although the approximate moisture content of the thin crepe is only about 20 per cent., the moisture is still not evenly distributed. After the superficial moisture has been removed by a cloth, drops of water appear at irregular intervals within a few minutes over the surface of the material. Also the slight increase in the thickness of the crepe along the edges will result in a higher moisture content in those parts of the strip.

With regard to the Sarawak jelutong refined in Singapore the experiments showed that the results by the absolute method were between 1.5 and 3.0 per cent. lower than those obtained by omitting the partial drying at 40°C. It is doubtful, however, to what extent the lower results by the absolute method are due to an increased tendency to oxidation in view of the excessively tough nature of the material and the increased liability to an irregular distribution of moisture. Further, the fact that the difference is not constant supports the contention emphasised above that the chief factor is the distribution of moisture. Considering that the material is exposed to a temperature only about 10°C higher than that of the atmosphere, it is considered highly improbable that the effect of oxidation in the relatively short space of time would be so appreciable. Further experiments are being carried out in connection with this point.

Mention might be made here that the methods employed by various workers vary considerably as regards the conditions for the ultimate drying of the material. In some cases the material is dried in an oven at 105°C for 18 or 24 hours, while in others desiccation is carried out under reduced pressure at a temperature of 70°C, a desiccating agent, such as calcium chloride, being also present in the vessel to accelerate the process. It is also possible to determine the moisture content of jelutong by boiling the material with xylol and measuring the amount of water that distils over.

On account of the variations in conditions of treatment differences between the moisture contents of samples from the same block are found, but it is difficult to estimate the amount

of variation due to difference of method and that due to the lack of homogeneity of the material. There appears little doubt that the latter is the chief factor.

It is generally admitted that the absolute method described above, although lengthy and requiring crepeing rolls, is likely to give the most accurate figure for the moisture content of a block owing to the error of sampling material with such a relatively high moisture content being avoided, and the fact that the weight of dry jelutong in the block can be calculated with a much greater degree of accuracy.

Such a method is scarcely applicable to a commercial laboratory in which the chief consideration is rapidity of working consistent with accuracy. A variation of the method originally described is therefore employed, but it must be pointed out that the results can only be regarded as less accurate in their degree of approximation than those obtained using the absolute method.

Variations in Moisture Contents of Separate Blocks.

The extent of the variations in the moisture contents of individual blocks was not realised until moisture determinations of consignments of Forest Department jelutong were being carried out both in this Department and by Messrs. L. A. Dreyfus & Co., Singapore, the purchasers of the material. In accordance with the plan adopted two half blocks from a small consignment of 80 blocks were selected at random, and the moisture content of the two half blocks, treated as one block, determined as described previously. The same procedure was adopted in Singapore except that the method employed for the determination of moisture consisted in the removal of small portions of the material which were dried at 105°C for 24 hours.

A difference of 11.2 per cent. was found between the results, the figure found in this Department being 30.2 per cent. and in Singapore 41.4 per cent. This experiment showed therefore the variation that might be expected between the moisture contents of individual blocks and the necessity for adequate sampling. As a result it was decided to make further determinations with series of blocks in consignments of jelutong from different sources.

This investigation was only rendered possible by the courtesy of the Singapore representatives of Messrs. L. A. Dreyfus & Co., New York, Messrs. H. G. W. Parmele and H. Lincoln Houghton to whom special thanks are due for their kindness in affording the writer the necessary facilities for the sampling of large consignments.

It is considered unnecessary to publish in detail the results of each series although the outline of the method followed in the case of the large consignments may be of interest.

Serially numbered cases of material at definite intervals, for example, every fifth case, were selected from a consignment. These cases were opened and, counting the blocks serially in each opened case in the same order, blocks at definite intervals, for example, every tenth block, were removed. Such a method has the advantage that a definite proportion of outside and central blocks from the various cases is obtained.

The blocks were divided into two, the moisture content of one portion being determined in the laboratory of Messrs. L. A. Dreyfus & Co., Singapore, the other half being brought back to Kuala Lumpur. In the latter case the loss in weight during transit was immaterial, since the material had been weighed in Singapore. The determination of the moisture content of the half-block brought back to Kuala Lumpur was carried out by the absolute method, the method employed by Messrs. L. A. Dreyfus & Co. being as previously described.

It must be pointed out that in this investigation the moisture content determinations have been made with half-blocks, which can be regarded as only approximately representative of whole blocks. The approximation is however reasonably accurate in view of the large proportion of the block taken as a sample, and it is considered that sufficient determinations have been made to permit of a statistical examination of the results.

The results of one series of determinations with F.M.S. material, in which every fifth case was opened and every tenth block in the opened cases taken as samples, are shown in Table I. In this consignment each case contained 24 blocks, arranged in two layers of twelve blocks, each layer consisting of three rows of four blocks.

TABLE I.

Results of Moisture Determinations on 26 Half-blocks of Jelutong drawn from a Consignment of F.M.S. Material.

Serial No. of case.	Serial No. of sample.	Relative position of block in case.	Moisture content. per cent.	Variation from mean. per cent.
1	1	Upper layer side	52.0	+1.6
1	2	Lower layer end	51.0	+0.6
6	3	Upper layer central	53.5	+3.1
6	4	Lower layer corner	49.3	−1.1
11	5	Upper layer side	49.8	−0.6
11	6	Upper layer corner	52.0	+1.6
11	7	Lower layer side	54.1	+3.7
16	8	Upper layer end	48.8	−1.6
16	9	Lower layer central	46.5	−3.9
21	10	Upper layer corner	51.9	+1.5
21	11	Lower layer side	54.8	+4.4
21	12	Lower layer corner	44.2	−6.2
26	13	Upper layer side	50.4	Nil
26	14	Lower layer end	48.3	−2.1
31	15	Upper layer central	43.1	−7.3
31	16	Lower layer corner	52.0	+1.6
36	17	Upper layer side	51.6	+1.2
36	18	Upper layer corner	49.6	−0.8
36	19	Lower layer side	49.6	−0.8
41	20	Lower layer end	52.8	+2.4
41	21	Lower layer central	52.0	+1.6
46	22	Upper layer corner	51.0	+0.6
46	23	Lower layer side	50.9	+0.5
46	24	Lower layer corner	44.0	−6.4
51	25	Upper layer side	54.4	+4.0
52	26	Lower layer end	53.4	+3.0

Average Moisture Content 50.4 per cent.

TABLE II.

Summary of Results of Moisture Determinations of Half-Blocks of Jelutong from various Sources.

Serial No.	Source of jelutong.	No. of half-blocks examined.	Percentage of blocks examined.	Moisture content. per cent.				Average moisture content, L. A. Dreyfus. per cent.	Difference. per cent.	Standard deviation.	Coefficient of variability. per cent.
				Maximum	Minimum	Maximum variation	Average				
1	Forest Department ...	17	20.0	41.2	31.4	9.8	36.0	Not determined.	...	3.32	9.22
2	Forest Department ..	19	20.0	42.8	33.5	9.2	38.7	Not determined.	...	2.61	6.74
3	Forest Department ...	17	10.0	50.1	37.9	12.2	41.9	Not determined.	...	3.14	7.50
4	F.M.S. ...	26	2.0	54.8	43.1	11.7	50.4	50.9	0.5	3.08	6.11
5	F.M.S. ...	21	2.0	56.2	43.2	13.0	51.2	53.3	2.1	3.29	6.43
6	Sarawak ...	29	1.5	42.2	33.3	8.9	36.2	41.7	5.5	2.36	6.52
7	Crude Sarawak, refined in Singapore ...	27	2.0	44.9	25.0	19.9	37.9	42.3	4.4	4.90	12.93

Mean "Coefficient of variability" = 7.92 per cent.

From these results it will be seen that, while the average moisture content of the consignment was 50.4 per cent., the results for the individual blocks showed variations from 43.1 per cent. to 54.8 per cent., a difference of 11.7 per cent.

Six other consignments of material from various sources were similarly examined, a summary of the results being given in Table II.

Excluding the crude Sarawak material refined in Singapore, these results show that there is a variation of 9 to 13 per cent. between the maximum and minimum moisture contents of individual half-blocks. The increased variation in the case of the Sarawak jelutong refined in Singapore is due to insufficient refining; an examination of the material showed that the refining process had been reduced to a minimum, the jelutong having been heated in water probably just sufficient to soften it before pressing.

It is interesting to note that approximately similar variations between the moisture contents are found in all consignments, although in the case of the Forest Department material a much greater percentage of the blocks was examined.

The results confirm those found with the original Forest Department consignments as regards the amount of variation between the moisture contents of any two half-blocks selected at random, and it is reasonable to assume that variations of a similar order would have been found if whole blocks had been used.

In this connection the results of a further experiment carried out with the crude Sarawak material refined in Singapore may be interesting. Six blocks of this material were selected at random, the moisture contents of the separate blocks being determined and found to be as follows:—

Serial No. of block.		Moisture content per cent.
1	...	42.8
2	...	37.0
3	...	42.2
4	...	35.0
5	...	31.1
6	...	26.2

From these results it will be seen that the difference between the maximum and maximum moisture contents is 16.6 per cent., the latter figure being in relatively close agreement with that shown for similar material in Table 11.

With regard to the figures for the moisture contents as determined by this Department and by Messrs. L. A. Dreyfus Co., Singapore, the results show that those obtained in this Department are lower in all cases. Since the difference is not constant, it appears likely to be due to variations in methods of sampling and technique.

The statistical examination of the figures was confined to the calculation of the "standard deviation" and "coefficient of variability" for each consignment.

The "standard deviation" has been calculated by taking the squares of the individual deviations from the mean, summing them and finding their square root after dividing the total by the number of samples examined. From the results it will be seen that the "standard deviation" varies from 2.36 to 4.90, being least for the refined Sarawak material and greatest for the crude Sarawak jelutong refined in Singapore.

In order to obtain a more intelligible measure of the variability between the various consignments the "coefficients of variability" have also been calculated, that is to say the amounts of the "standard deviations" have been expressed as percentages of the average moisture contents.

The "coefficients of variability" vary from 6.11 to 12.93, being lowest for one of the consignments of F.M.S. material and highest for the crude Sarawak jelutong refined in Singapore.

Since the "coefficient of variability" is an index of the percentage variation by which the moisture content of any one half-block is liable to differ from the mean moisture content of all the half-blocks in that consignment the average "coefficient of variability," 7.92 per cent., affords an indication of the average variation in the moisture content of any two blocks selected at random from any commercial consignment.

Remarks and Conclusions.

The results of this investigation show that the present methods for the determination of the moisture content of a consignment of jelutong are unlikely to give satisfactory results, since the moisture in any individual block is not evenly distributed, the moisture contents of individual blocks are liable to considerable variation and frequently insufficient blocks are selected for a sample.

The situation demands therefore that definite standards shall be laid down as regards both the number of sample blocks to be taken, and the actual selection of the material, for example, 1 per cent. of the blocks from a consignment, attention being also paid to the proportion of outside and inside blocks from the opened cases. Further, a definite procedure should be laid down as regards the method of sampling individual blocks, the weight of the material to be taken for examination, the temperature to which the material should be heated and the duration of the heating.

If the same procedure is followed in all cases then it is reasonable to expect that over a period the variations from the true mean in favour of either party will cancel out. Buyers maintain that under present conditions this cancellation occurs, although it must be admitted that with some of the present haphazard methods of sampling the chances are remote.

The analysis of 1 per cent. of the blocks in a consignment entails a considerable amount of work, and it may be held that the value of the material is not commensurate with the expense involved. In that case an alternative, but less satisfactory, method of valuation would be the determination of the moisture content on a smaller percentage of blocks and the classification of the material by 5 per cent. increments in moisture content, for example, 30—35 per cent., 35—40 per cent., 40—45 per cent., the price for the class being based on its average moisture content.

Although neither method is likely to give a true mean of the moisture content of any one consignment it is submitted that the adoption of a definite procedure must result in the differences in favour of buyer and seller eventually cancelling out.

Apart from the question of moisture content more attention might be given to the cleanliness of the material as regards the valuation of a consignment.

An examination of commercial consignments of jelutong frequently results in the discovery of small pieces of bark, twigs and other debris in the material, showing that either the latex has not been strained before coagulation or the crude coagulum has not been sufficiently cleaned before refining.

In view of the recent investigations on the oxidation of jelutong it is possible for any of these pieces of debris to be the centre of infection for this type of deterioration, especially if there is any likelihood of contamination with iron. Since deterioration due to oxidation frequently results in serious financial loss to manufacturers of chewing gum, it is reasonable to suggest that a small reduction in the price of jelutong showing the presence of much debris will result in the producers endeavouring to improve the quality of their product. The examination of the jelutong for debris could be carried out on the blocks selected for moisture determination in order to avoid breaking up any further blocks in the consignment.

If this suggestion is adopted the valuation of the material will not be entirely dependent on its moisture content and at the same time a general improvement in quality may be expected.

Summary.

1. The question of the distribution of moisture in a block of jelutong is discussed.

2. Various methods employed for the determination of the moisture content of the material are described.

3. The results of determinations of the moisture contents of series of blocks from consignments of jelutong from different sources are given and suggestions made regarding the amendment of the present basis for valuation of the material.

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"The Manufacture of Palm Oil."

The following is an abstract of an important publication by Ir. H. N. Blommendaal, Chief of the Chemical Division at the General Experiment Station of the A.V.R.O.S., Medan, Sumatra, entitled "The Manufacture of Palm Oil"[1] *a copy of which was presented to the writer during his recent visit to Sumatra.*

In view of the high state of development of the oil palm industry in that country and its growing importance in Malaya it was considered advisable to make a detailed abstract, since the preparation of oil palm products is a lengthy process, demanding attention to detail at every stage if the maximum quantities of first grade products are to be obtained.

Thanks are due to the Director of the General Experiment Station of the A.V.R.O.S. for permission to publish this abstract.

The writer also wishes to acknowledge the assistance rendered by Mr. L. A. J. Rijk, Librarian and Translator of this Department, in translating into English the original publication in Dutch.

History.

Although records show that nearly five hundred years ago palm oil was being used by the natives in West Africa, both for edible purposes and as a cosmetic, it was not until the latter part of the nineteenth century that the vast possibilities of the industrial application of oil palm products were realised. In this connection it is interesting to note that palm oil was first imported in quantity into England in 1790, the total amount for that year being 130 tons.

In the early days of the industry considerable difficulty was experienced as regards the factory plant, especially the design of a machine for the separation of the pericarp from

1. Mededeelingen van het Algemeen Proefstation der A.V.R.O.S., Algemeene Serie No. 33., De Fabricage van Palmolie, door Ir. H. N. Blommendaal.

the nuts. Among the firms specialising in plant at that time may be mentioned Friedrich Haake, who were the winners of the prize offered in 1902 by the Committee of Colonial Economics in Berlin for the best method of the treatment of the fruit. Depericarping machinery constructed by this firm was sent out to West Africa, but was not entirely successful.

The idea of pressing the whole fruit seems to have originated with the firm Fournier of Marseilles, who constructed a plant for erection in Dahomey. The fruits were first pressed cold; the residue was separated into pulp and nuts, the pulp being heated and pressed, while the nuts were cracked separately.

The German firm, Friedrich Krupp, improved upon this process by mashing the fruit hot before pressing, thereby increasing the yield of oil. This firm erected for the Altona Bahrenfeld Syndicate at Maka in North Cameroon a factory which, as regards the general arrangement of the plant, was similar to that in many of the factories now working in the East Coast Sumatra.

As result of estate working it was realised that a considerable advantage could be gained by the direct treatment of the fruit bunches, and the above-mentioned firm constructed a threshing machine for the separation of the fruit from the bunches, but the outbreak of war in 1914 hindered further progress in this direction.

Development of Industry in Sumatra.

The cultivation of oil palm in Sumatra commenced about 1914, 1,272 hectares being planted by the end of 1916. Rapid progress has since been made and the figures for 1926 show that the area has increased to 27,141 hectares (excluding the estates of the Handelsvereeniging Amsterdam). About one third of this area is in bearing, the figures for exports of oil palm products for the year being 11,714 tons of palm oil and 2,061 tons of palm kernels respectively.

From the commencement the factory process followed that formerly adopted in the West Coast of Africa. The fruit was steamed in open pans and pressed in handpresses. The pulp was separated from the nuts, which were cracked in a centrifugal cracker, while the pulp was heated and pressed to recover a further quantity of oil.

The first large factory was that on Poeloe Radja Estate, belonging to the Rubber Cultuur Maatschappij "Amsterdam". The plant, that was designed by Dr. E. Fickendey and constructed by Fr. Krupp, has been taken as a model by all the factories now working in the East Coast Sumatra.

Outline of Factory Process.

Before describing the various processes involved in the treatment of the fruit it is considered advisable to outline the method at present in general use in Sumatra. This is shown diagrammatically on page 237.

Harvesting and Transport of Bunches.

No special precautions are taken at present as regards harvesting the bunches which are allowed to fall to the ground, the compact nature of the bunch preventing damage.

The bunches of fruit are brought to the factory on the narrow gauge estate railway. On large estates the trucks are hauled by steam engines, in which the waste from the factory can be used as fuel.

Transfer of the fruit bunches from one truck to another should be avoided, since this always results in the bruising of the fruit and an increase in the acidity of the resultant oil.

Sterilisation of Bunches.

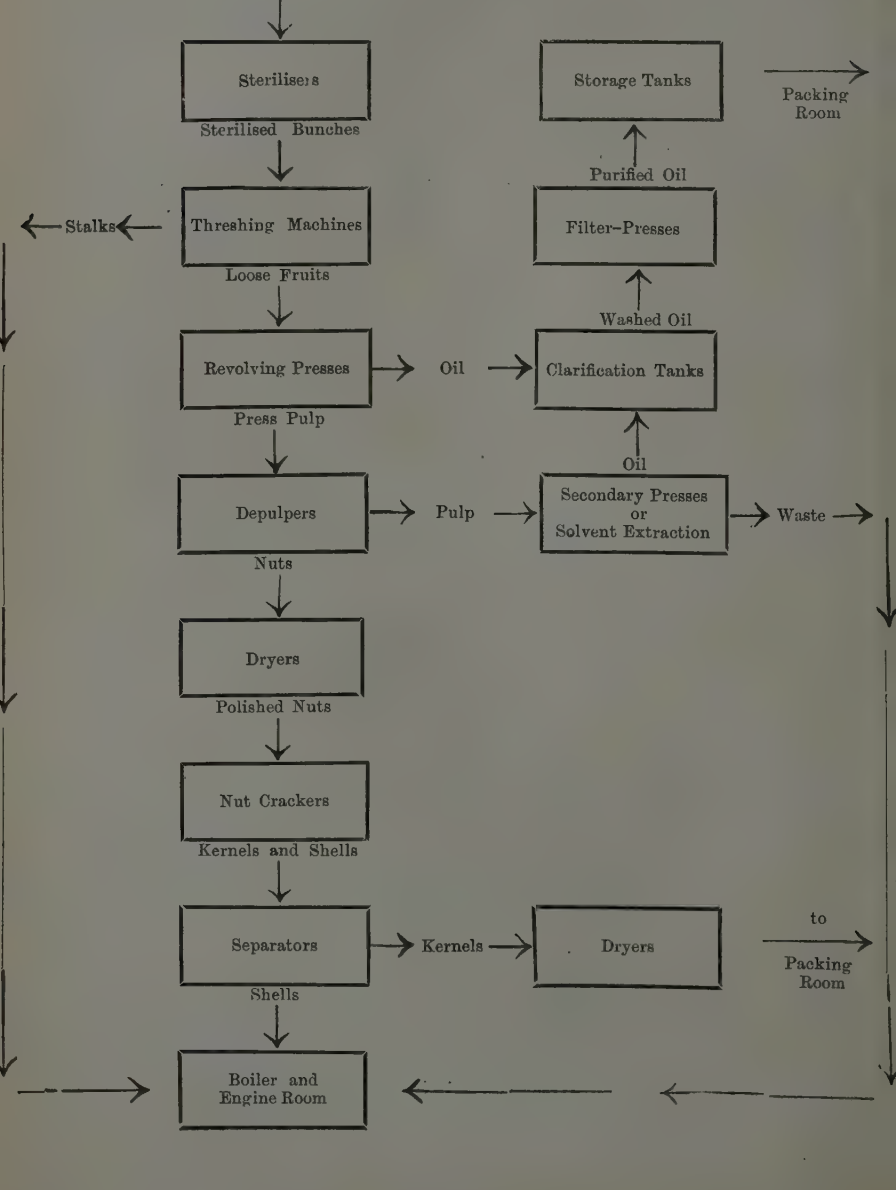
The method of sterilising the fruit bunches under pressure, as opposed to the steaming of the loose fruits, has been adopted for the following reasons:—

(*a*) Mucilaginous and protein matter are coagulated more rapidly, thereby preventing the formation of emulsions during the expression of the oil.

(*b*) Formation of free fatty acid is prevented.

(*c*) Intensive evaporation of moisture, amounting to 5—10 per cent. by weight of the fruit, takes place, facilitating the expression of the oil. By steaming under pressure and then treating in a vacuum this amount can be increased to 15 per cent.

TREATMENT OF OIL PALM FRUIT IN SUMATRA.



(*d*) The kernels are loosened in the shells as a result of the intensive evaporation.

(*e*) Estate control is facilitated owing to the elimination of collecting sheds, and a reduction in manual labour is possible.

(*f*) Fresh material is always available, a great advantage in factory control.

The apparatus consists of an autoclave or a closed vessel into which steam is passed. Autoclaves are of either the vertical or horizontal type, and are constructed in various sizes. Those of the vertical type are charged at the top by means of an elevator, the sterilised bunches being discharged at the bottom. Those of the horizontal type are more suitable for large installations and are usually constructed to take small trucks, into which the fruit bunches are loaded. These trucks, the sides of which are made of expanded metal, are run into the steriliser either on rails or suspended from a monorail. Sterilisers capable of holding 6 trucks, each truck containing one ton of bunches, are employed on large estates.

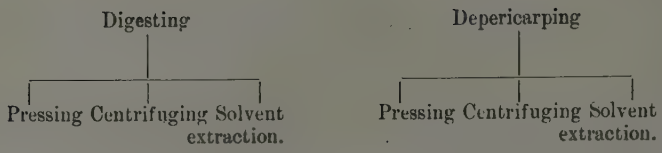
Threshing of Bunches.

After sterilisation the fruit is separated in a threshing machine that works on the principle of a mechanical shaker, the bunch being subjected at the same time to a rotary motion in order to expose all parts to the action of the revolving arms. The fruits falling between the arms are separated from the light debris either by revolving screens or by subjecting the material to a blast of air, which carries away this debris.

Outline of Methods for Preparation of Palm Oil.

When considering the preparation of palm oil there are three possible methods of treatment for the fruit according to whether the fruit is digested whole or separated into nuts and pericarp, the latter being treated separately.

The following table shows the different possibilities:—



The question of the most economical method of treatment is not yet settled, although it may be stated here that digestion of the fruit followed by pressing is the method in general use in the East Coast Sumatra. The centrifugal method is employed in the Federated Malay States. Neither depericarping methods nor digestion followed by solvent extraction have been generally adopted.

Digestion of Fruit.

Before the whole fruit can be pressed it must be mashed or digested in order to loosen the pulp from the nuts and to rupture the oil cells. As a result the mass of fruit becomes more compact, and the amount of a press charge can be increased by 50 per cent, resulting in a more uniform pressure and also an increase in the yield of oil.

The process of digestion is carried out in a steam-jacketed mashing kettle fitted with a vertical shaft, that makes from 60 to 100 revolutions per minute. Arms are fixed to the shaft and gradually loosen the pulp from the nuts.

Pressing of Whole Fruit.

The most successful type of hydraulic press is known as Krupp's "Swing-box" press. This press has two cages, one of which can be emptied and refilled, while the contents of the other are being pressed. The two cages, which revolve on one of the pillars supporting the press, can be changed over by a simple lever action, thereby ensuring rapid working. The pressure is supplied by a plunger pump in which either water, mineral oil or coconut oil is used as a medium. The cage holds about 130 lbs. of digested fruit and, since 10 charges can be treated per hour, the working capacity of the press is equivalent to about 1300 lbs. of fruit per hour.

When several presses are installed it is more convenient to supply pressure from an accumulator, having a working

pressure of from 750—1000 lbs. per square inch. The pressure in the accumulator is maintained by the pumps and, since the action of an accumulator is more rapid and more even than that of a pump, the working capacity of a press can be increased in this way to approximately 1 ton of fruit per hour.

A different type of press has recently been introduced. This consists of two stationary cages, each of which in turn can be closed by a sliding plate. The material in one cage is pressed, while the other cage is being emptied and refilled, the piston acting as an ejector. A capacity of 1 ton per hour can also be obtained with this type of press when accumulators are used.

Attempts have also been made to introduce continuous presses based on the principle of an Anderson oil expeller. Up to the present these have not given satisfaction, although it is understood that the most recent experimental trials with these presses have been distinctly promising.

Yield of Oil.

The output of oil depends on several factors among which may be mentioned the following:—

(a) The moisture content of the material. This point has already been referred to when discussing the question of sterilisation of the bunches.

(b) The temperature of the material. As far as possible a temperature of 70°—80°C should be maintained.

(c) The insertion of press plates and the size of the perforations in the cage for the passage of the oil.

(d) The extent to which pressure is applied. Palm oil is easily expressed, and it is unnecessary to raise the pressure more than a $\frac{1}{4}$—$\frac{1}{2}$ ton per square inch.

In general it may be said that between 85 and 90 per cent. of the oil present in the sterilised fruit is obtained. Since the fresh fruit contains 28—29 per cent. of oil the treatment of the whole fruit expresses an amount of oil equivalent to about 25 per cent. of the weight of fruit. In practice, however, the whole of this quantity of oil is not recovered owing to small losses occurring in the purification process.

The pericarp residue still contains oil amounting to approximately 20 cent., calculated on the moisture-free material.

Centrifugal Treatment of Fruit.

Reference is made to the centrifugal treatment of fruit, the method in general use in the Federated Malay States. It is stated that the yield of oil obtained from the whole fruit by this method is approximately the same as that obtained by pressing.

Depericarping.

This method has for its object the separation of the oil-bearing material from the nuts before recovering the oil according to one or other of the processes described. One of the advantages claimed for the method is that as a result of depericarping the capacity of the press, centrifuge or solvent extractor is increased proportionately.

Although many attempts have been made, no satisfactory depericarper for continuous working has yet been designed, the chief difficulty being that the machine becomes choked with the oily watery pericarp.

Further, although the capacity of press or centrifuge is increased, the yield of oil per unit weight of fruit is actually less than when treating the whole fruit. Also the fibre retained on the nuts always contains a greater percentage of oil than that from fruits pressed whole.

Treatment of Press Residue.

The separation of the press residue into nuts and fibre is usually carried out in closed revolving octagonal screens, the sides of which are made of expanded metal through which the nuts pass. It is preferable to transfer the material while still hot to the depulper in order to permit of evaporation, thereby facilitating separation.

These screens, about 20 feet long and 4 feet in diameter, do not work continuously. About two tons of press residue is treated per charge, the period required for separation being about 20 minutes.

Continuous depulping screens are also used; these are usually about 24 feet long and are constructed partly of bars placed lengthwise and partly of expanded metal. In consequence of a slight inclination of the axis the material gradually traverses the length of the screen, the pulp falling between the bars or through the expanded metal, while the nuts are collected at the lower end.

Drying facilitates separation and in some depulpers arrangements are made for the introduction of a hot air blast for this purpose.

The further treatment of the pulp varies; on some estates the pulp is discarded, on others it is pressed a second time, while recently solvent extraction has been introduced.

Second Pressing of Pulp.

In large factories, where sufficient fruit, 1—1¼ tons of fresh fruit per hour, is being treated, the pulp is heated and subjected to a second pressing of 2½—3 tons per square inch. The press is specially designed to hold about 400 lbs. of pulp per charge, and the pressure effect is increased by the insertion of press plates. The process is however slow, not more than 600—700 lbs. of pulp being pressed per hour. The yield of oil approximates to 8—10 per cent. of the weight of material treated, equivalent to an output of 60 lbs. of oil per hour. This corresponds to approximately 2.3 per cent. of the weight of fresh fruit and 8 per cent. of the total quantity of oil in the fresh fruit. The residue still contains oil amounting to 8—10 per cent., calculated on a moisture-free basis.

Solvent Extraction of Residue.

On account of the low output of oil from the second pressing considerable attention has been given to the question of the solvent extraction of the residue from the whole pressing of the fruit, since with such a method practically the whole of the remainder of the oil can be recovered.

The principles underlying the process of solvent extraction are so well-known that it is considered necessary to refer only to those points concerning the application of this process to the treatment of oil palm pulp. This material is very

suitable for solvent extraction on account of its fibrous nature and the ease with which the solvent can penetrate.

For satisfactory extraction the moisture content of the material should not exceed 10 per cent. but, since drying is apt to be uneconomical, it is preferable to rely upon the solvent gradually displacing the water in the residue, in which case the liquid drawn off from the first treatment with solvent will consist largely of water.

The rapidity with which the oil dissolves increases with the temperature and the stirring of the material. Stirring is only possible, however, if the whole of the residue, both nuts and fibre, is extracted.

The choice of a solvent is important and, since large quantities are required, an adequate supply of solvent at a low cost is one of the essentials for the economic working of the extraction process.

Importation of the solvent from Europe is too expensive and solvent naphtha (boiling point 85°—105°C), which is a product of the local oil refineries and available in large quantities at cheap rates, has therefore been chosen. Owing to the inflammable nature of this liquid special precautions must be taken in the factory as regards the possibility of an outbreak of fire.

Particular attention must also be given to the question of loss of solvent which must be reduced to a minimum if the process is to be successful.

On a large scale the battery system working on the counter current principle is preferable, that is, the fresh solvent comes in contact with the almost exhausted residue. Four extractions are usually sufficient to exhaust the material to an oil content of approximately 1 per cent.

It is still doubtful whether the material from the press should first be depulped or whether the whole mass should be treated.

The advantages of the latter system are as follows:--

(a) No oil is lost on the fibre adhering to the nuts.

(b) Stirring of the material is possible, thereby facilitating the solution of the oil.

(c) The subsequent separation of the nuts and fibre is simplified on account of the removal of oil and moisture.

There is, however, the general objection that the size of the extractor must be increased, although this is in reality a relatively small item affecting only the capital cost of the plant.

Attention is drawn to the fact that, if the process of pressing the whole fruit combined with solvent extraction is adopted, it will also be possible to dispense with the thorough screening of the material after threshing, except for the removal of large pieces of debris. A small amount of oil is always lost in the light debris from the threshing machine, but this loss can be obviated if the whole material is pressed and solvent extracted.

The bleaching of solvent extracted oil presents some difficulty, but this can be avoided to a large extent by using fresh pulp and carrying out the extraction at as low a temperature as possible.

Comparison of Systems.

It is only possible to make an accurate comparison of those systems that are actually being worked on a factory scale. Thus, the system of pressing the whole fruit can be compared with that of centrifuging. Assuming that these two systems give the same yield of oil and that the running expenses are approximately equal, the difference is determined by capital expenditure.

In the case of the above systems the proportions are stated to be as follows:—

(a)	Pressing whole fruit	... 65
(b)	Centrifuging whole fruit	.. 100

Further, owing to the smaller capital cost of the press system both the depreciation and upkeep expenditure will be correspondingly less.

With regard to the general treatment of the fruit the most promising system for future investigation appears therefore to be pressing followed by solvent extraction.

Purification of Oil

The crude oil from the press contains a large proportion of water and solid impurities as the figures in the following table show:—

	Water per cent.	Solid impurities per cent.
Oil from first pressing ...	10	12.5
Oil from second pressing ...	35	15.

The crude oil is run into a tank and hot water, equivalent to half the volume of the oil, is added. Live steam is passed in causing the water and impurities to settle, and the oil to rise to the surface. The washed oil, now containing from 0.5—1.0 per cent. of moisture and 0.1—0.2 per cent. of solid impurities, is transferred to a storage tank, in which it is maintained at a temperature of from 90°C—100°C by means of a closed steam coil to facilitate separation of solid impurities and to allow moisture to evaporate. The original layer of sludge is transferred to another tank and treated with a further quantity of steam in order to recover more oil.

The oil from the storage tank is passed through a filter-press in which the small amount of solid impurities is removed and the moisture content further reduced to 0.2—0.3 per cent.

Attention is drawn to the fact that a minute percentage of solid impurities has a much greater influence on the storage qualities of the oil, as regards the formation of free fatty acid, than a relatively large percentage of moisture.

A series of experiments carried out with oil containing varying proportions of moisture and solid impurities showed such a considerable increase in the development of acidity in those samples containing solid matter that it is in the interest of the producer to export a clean oil.

The possibility of employing a centrifugal separator, either de Laval or Sharples supercentrifuge type, for the purification of the crude oil has been investigated, but experiments showed that this was not feasible on account of the solid impurities clogging the apparatus.

A separator of the centrifugal type can be substituted for the filter-press, and such an installation would appear to be an economical proposition on account of the higher quality of the resultant oil, since with a centrifugal extractor, in addition to removing all the solid impurities, it is possible to remove a greater proportion of the water than with the filter-press.

Packing and Shipment of Palm Oil.

The packing of palm oil is essentially an economic problem connected with expenditure on freight and marketing.

The method adopted should satisfy the following requirements:—

(*a*) Loss by leakage must be avoided.

(*b*) The quality of the oil must not be affected by the container.

(c) The package must be handled easily with the means of transport available on the estate.

(*d*) Packing should be cheap as regards both material and freight.

(e) Sampling should not be excessive.

Standard casks, holding about 13 cwts. of oil and similar to those used in the West African trade, were originally tried, but their use was discontinued owing to their heavy weight and the leakage of oil during transit.

The usual method employed is the 40-gallon firwood barrel. These barrels are handled easily and the wood has no influence on the oil, the slight increase in the free fatty content of the oil during transit being dependent on the impurities and moisture content of the oil. By coopering the barrels carefully and coating them inside with glue losses by leakage can be reduced considerably. The cost of these barrels amounts to approximately $46/- per ton of oil, which is high in proportion to the total manufacturing costs of the oil.

Steel drums of various dimensions have been tried, but have not been found satisfactory, chiefly on account of heavy shipping charges and the difficulty of ensuring the return of

the empty drums. There was also the additional difficulty of cleaning the drums.

Experiments showed that the increase of the free fatty acid content of high grade oil stored in an iron drum was normal, and that there was also no appreciable increase in the iron content of the oil during storage.

Collapsible iron barrels made by the Kenward Barrel Company, Ltd., London, have also been used. These barrels are made in two halves, several of which can be nested or stacked, thereby saving freight. The system has not been adopted on account of the initial cost of the drums and the difficulty of securing the return of the empties.

The method of shipment in kerosene tins, holding 4 gallons, has also been suggested, but the chief disadvantage of this method would be the large number of tins to be opened in order to obtain a representative sample of oil from a consignment.

There seems little doubt that the solution of the method of packing of palm oil lies in the development of the shipment of oil in bulk for which method the cost of both packing and freight is considerably less. Compared with shipment in 40 gallon barrels a much greater amount of oil can be stowed per unit space, the increase amounting to approximately 80 per cent., while the freight rates for shipment in bulk are also considerably less than those for barrel shipment.

In spite therefore of the large amount of capital expenditure required for tank wagons and a permanent tank installation both on the estate and at the port efforts should be made to develop this method of shipment in view of the considerable amount of saving effected over a long period of working.

Drying of Nuts.

After leaving the depulper the nuts must be dried before cracking, the treatment amounting to both a further depulping and a drying process.

When the nuts leave the depulper a small tuft of fibre adheres to the nut where it was joined originally to the

bunch-stalk. Unless removed this tuft causes difficulties in the cracking process and the nuts are therefore passed through a horizontal drum into which smoke gases or hot air at a temperature of approximately 150°C are introduced. Owing to the drying action and the friction of the nuts the tufts of fibre are easily removed and the moisture content of the kernels is reduced to 12—15 per cent. This reduction is sufficient for the treatment of the nuts in centrifugal crackers, but not in roller crackers. In the latter case the moisture content should not exceed 10 per cent., and this further reduction can only be effected by storing the nuts for a period before treatment.

Cracking of Nuts.

Nut crackers of the centrifugal type are in general use in Sumatra. On account of the variations in size it is advisable to sort the nuts into three sizes and have a separate cracker for each size of nut, the speed of the separate crackers being adjusted accordingly. In this way the number of uncracked nuts for return to the cracker can be reduced considerably.

In the case of roller crackers the nuts are cracked by passing between rollers, a pair of which is so arranged that the space between the rollers increases along the axis A sorting apparatus over the rollers directs the nuts to the space between the rollers corresponding to their size, small nuts to where the rollers are close, large nuts where the space between the rollers is greatest. The rollers revolve inwards and are grooved, so that the nuts cannot rebound when they fall on the rollers. Good results have been obtained with this type of cracker, provided that the nuts are thoroughly dry before treatment.

Separation of Kernels and Shells.

The separation of kernels and broken shells is usually effected in a tank containing a suspension of clay and water, specific gravity 1.15—1.20, in which the kernels float while the shells sink. It is important to maintain the specific gravity of this suspension, since the kernels rise more quickly as the specific gravity increases. Continuous working apparatus are available, in which the kernels can be skimmed

from the surface and the shells dredged from the bottom of the tank.

The firm of Friedrich Krupp has recently constructed a water separator based on the principle of an ore separator. The water in the apparatus flows intermittently, so that the kernels are gradually forced upwards, while the shells gravitate to the bottom of the tank. Good results are said to be obtained with this apparatus, which has the additional advantage that the subsequent rinsing of the kernels is unnecessary.

In addition to these two wet methods, dry methods of separation have also been tried. Such methods are usually based on the difference in the shape of the kernels and shell fragments, but up to the present no satisfactory machine has been designed.

Drying and Packing of Kernels.

The kernels from the clay-bath are rinsed with water to remove adhering clay and dried until the moisture content has been reduced to between 5 to 6 per cent. Drying methods vary, on some estates the kernels are sun-dried, on others they are dried near the boiler, while in some factories special drying stoves have been installed.

The kernels are exported in bags holding about 160 lbs.

Factory Control.

In view of the lengthy nature of the process and the possibility of losses, more particularly palm oil, at various stages accurate factory records should be kept. If these statements are compared for similar periods a valuable indication will be obtained both of estate practice as regards harvesting of the fruit bunches when ripe and factory practice as regards yield of products.

Since it is practically impossible to draw representative samples of fruit from the bunches and to determine with any great degree of accuracy the average oil content of the fruit an indirect method of calculation must be adopted. This consists in the determination of the losses of oil at different stages of the process, for example, oil in the waste from the

threshing machine, oil in the fibre adhering to the nuts and oil in the residue from the press or solvent extractor. If the sum of these losses is added to the actual weight of oil recovered the average oil content of the fruit or of the fruit bunches can be calculated.

In this connection it is important to note that the results will only be comparable so long as fresh bunches are being treated. If fruit is stored for a few days a decrease in weight takes place owing to loss of moisture, and therefore it is useless from the point of view of factory control to compare yields of oil from fruits which may have been stored for different periods.

Routine chemical analyses form an important part of factory control and for this reason a chemical laboratory should be installed, in which, in addition to the work indicated above, analyses in connection with the quality of the final products can also be carried out.

The average composition of fresh fruit may be taken as follows:—

				per cent.
Fresh Fruit	Pericarp 60 – 65 per cent	... ...	Moisture	37 – 41
			Oil	43 – 47
	Nuts 35 – 40 per cent	Shell 80 per cent.	Residue	15 – 17
		Kernel 20 per cent	Moisture	25 – 30
			Oil	45 – 50
			Residue	25

Expressed as percentages of the weight of fresh fruit the average composition would be as follows:—

	per cent.
Moisture	... 24
Pericarp oil	... 28—29
Pericarp residue	... 10
Shell	... 30
Kernel	... 7—8

In general the first pressing yields about 82.5 per cent. of the oil present in the fruit bunches, equivalent to approximately 25 per cent. of the weight of the fruit and 12 per cent. of the weight of the bunches.

The second pressing yields 7.5 per cent. of the total quantity of oil in the fruit bunches, equivalent to approximately 2.1 per cent. of the weight of fruit and 1.0 per cent. of the weight of the bunches. Solvent extraction gives a much higher percentage, the total oil recovered by pressing and solvent extraction rising to 98.5 per cent. of the oil present in the fruit bunches.

The figure of 7—8 per cent. for the weight of kernel relates to fresh kernels, the weight of the dry kernels being approximately 5.5 per cent. of the weight of fruit or 2.6 per cent. of the bunches.

Waste Products from Factory.

Attention is drawn to the utilisation of the waste products from the factory, for example, residue of bunches, press pulp and shell fragments. On most estates these materials are used as fuel, in which case the ashes should be returned to the field on account of their phosphate and potash contents.

In view of the large quantities of steam required a good water supply for the factory is essential. Much boiler trouble can be avoided by paying attention to this point when selecting the factory site.

Properties of Palm Oil and Palm Kernel Oil.

Palm oil consists principally of palmitin, and for this reason the acidity of the oil is calculated as palmitic acid.

The well-known orange-red colour is due to a mixture of carotin and xanthophyll.

The following table shows some of the more important analytical constants of the oil:—

Specific gravity at 30°C. (dependent on acidity)	... 0.917—0.908
Melting-point (dependent on acidity)	... 27°—42.5°C.
Saponification value	... 198.7—201.9
Iodine value	... 53.6—57.9
Solidifying point of fatty acids	... 40°—47°C.

Palm kernel oil is similar in composition and properties to coconut oil. The principal glyceride present is laurin, and the acidity of the oil is therefore usually calculated as lauric acid.

The following table gives some of the more important analytical constants of the oil:—

Specific gravity at 40°C.	... 0.912
Melting-point	... 23°—26°C.
Saponification value	... 241—255
Iodine value	... 10—23.5

Uses of Palm Oil.

The principal uses of palm oil may be summarised as follows:—(a) soapmaking, (b) candles, (c) edible purposes, (d) tin-plate manufacture, (e) fuel.

The first two applications of the oil are so well-known that further comment is unnecessary.

With regard to the use of palm oil for edible purposes oil of low acidity is suitable, since it possesses the right consistency, and further an edible fat prepared from this oil shows no tendency to turn rancid on account of the absence of glycerides of low molecular weight. Since shipments of the oil can now be guaranteed to arrive in Europe with an acidity not exceeding 4 per cent., calculated as palmitic acid, there would appear to be distinct possibilities for the utilisation of increasing quantities of this oil for edible purposes. Bleaching is necessary, but this presents no difficulty, provided that the oil has not been overheated during the process of manfacture.

Palm oil is also being used to an increasing extent in the tin-plate trade, for which purpose the oil is suitable on account of its vaseline-like consistency. In this case the maximum limit of acidity allowed, 20 per cent. calculated as palmitic acid, is much greater.

As a fuel for internal combustion engines the use of palm oil is likely to be restricted to countries, such as Belgian Congo, where imported mineral oil is expensive and palm oil comparatively cheap. For this purpose it is essential that the oil should be free from dirt, and further a special

injection apparatus and carburetter is necessary to volatilise the oil, which would have to be kept liquid in the supply tank.

Position of Oil Palm Products in the World's Markets.

The total amount of palm oil imported into Europe and America during 1926 amounted to 188,057 tons, the principal importing countries being Great Britain 76,627 tons and the United States of America 62,834 tons. Increasing amounts of this oil are being imported by the latter country, the figures showing an increase of approximately 18,000 tons between 1924 and 1926.

From the figures given in a previous section it will be seen that the production of oil in Sumatra for that year, 11,714 tons, amounted to only approximately 6 per cent. of the total quantity imported.

With regard to the relative importance of the various countries producing palm oil the figures for 1924 show that of a total of 185,290 tons no less than 129,100 tons were exported from Nigeria, French Dahomey coming second with 17,210 tons and Belgian Congo third with 14,100 tons.

During recent years the price of palm oil has been comparatively stable as the figures in the following table show:—

Year.	Price of palm oil per ton.		
	£	s.	d.
1923 ...	36	0	10
1924 ...	39	11	8
1925 ...	40	8	4
1926 ...	36	19	8

The total amount of palm kernels imported into Europe and America during 1926 was 604,746 tons, the principal importing countries being Germany 234,838 tons and England 217,401 tons. In the case of Germany the annual imports have more than doubled since the year 1924.

From these figures it will be seen that the production of kernels in Sumatra for the year 1926, 2,061 tons, was of but little consequence.

The figures for 1924 show that the principal producing countries for palm kernels were Nigeria, which produced no less than 356,900 tons out of a total of 512,900 tons, Sierra Leone coming second with 62,100 tons.

During the past few years the price of palm kernels has also shown but little variation as the following figures show:—

Year.	Price of palm kernels per ton.		
	£	s.	d.
1923 ...	18	18	3
1924 ...	21	5	2
1925 ...	21	7	5
1926 ...	20	5	9

No palm kernel oil is at present being produced in Sumatra, partly on account of the output of kernels being insufficient to warrant the erection of the necessary plant, but principally on account of the convenience of shipping kernels rather than oil and cake. Also, a ready market exists in Europe for palm kernel cake, which would be difficult to dispose of locally, and it is likely therefore that the present method of shipment of kernels will continue.

In view therefore of the comparatively stable prices of oil and kernels and the fact that the total annual production of palm oil is less than 5 per cent. of the world's total annual production of animal and vegetable oils and fats the establishment of an oil palm estate is not likely to be attended with great risks. Large companies and syndicates engaged in the cultivation of tropical crops with fluctuating prices, for example, rubber and tobacco, are well advised to invest their reserve funds in oil palm, which should yield a steady profit.

C. D. V. G.

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Land Available for Alienation in the Kuala Kangsar District of Perak.

With reference to Appendix C of the article on "System of Land Tenure in the F.M.S.", page 192 of the present volume of this Journal, it was stated that 110 square miles of agricultural land was available for alienation in the Kuala Kangsar District.

The District Officer, Kuala Kangsar has since pointed out that although this figure was approximately correct when the article was written, it is no longer so, owing to recent extensions of the Malay Reservations in that District. There is now very little land in the Kuala Kangsar District available for alienation, below 1500 feet in elevation.